

# ASSESSMENT OF THE USE AND IMPACT OF STYLOSANTHES GUIANENSIS CIAT 184 IN CHINA

by

C. Devendra and C. Seré

## EXECUTIVE SUMMARY

The report provides a comprehensive assessment of the use and impact of *Stylosanthes guianensis* CIAT 184 in South China, which was introduced there in 1982 through the IDRC supported international network on tropical pastures (RIEPT) coordinated by CIAT. It provides a background to animal production in China, examines current use of the legume for seed and meal production, and in pastures; various aspects of institutional capacity; linkages between institutions; implications of the findings; and suggestions for follow-up. The expanding use of this germplasm is impressive especially in Guangdong and Hainan provinces, but also elsewhere to seven other provinces, with areas planted in 1993 in the Guangdong province estimated at 5200 ha for the new cultivar CIAT 184 and 24,000 ha of the traditional variety Graham. The legume is used (a) as a monoculture crop (for seed or meal production), (b) as a cover crop in plantations eg rubber and mangoes, and (c) in pasture with grasses. The average forage yield is 87.34 MT/ha/yr of fresh material under a cutting regime of four times per year and seed production 375 kg/ha based on an annual harvest. The information base is rather weak but it is estimated that a total of 113 000 ha (4.7% of the farm land of Guangdong province) are grown to Stylos. This involves a total of about 108 000 farming families. Persistence is not clear but there is evidence of damage by low temperatures in Northern Guangdong. In Guangdong province the major advantage of CIAT 184 is a higher production (about 20 %) This is possibly related to later flowering than Graham. This nevertheless limits seed production in Guangdong, thus requiring introduction from Hainan island (The most tropical region of China). This need for specialization has been a limitation on the diffusion in Guangdong and other regions given the existing infrastructure for seed trade. In Hainan the major advantage besides the good market for seed is the higher anthracnose tolerance. The potential for further expanding its use is very promising.

The research capacity is weak, but there exists a core of very bright young scientists, trained overseas, who are very valuable contact points. Excellent linkages exist between institutions in which there exists a loose network on tropical pastures and legumes, contact with provincial Departments of Agriculture, Institutes of Agriculture or Animal Husbandry, all of which are encouraged by the Ministry of Agriculture in Beijing. Several implications of the findings are discussed, and in particular the value of building on the past efforts to promote more intensive use of the germplasm and seek sustainable development, use and development of upland areas, and technology transfer within the Asian region. A key suggestion for further research and development activities is to convene a Workshop to assess and discuss more fully the advances that have been made, measurement of the impact and consensus for future research and development direction.



## **1. Background**

Declining funding for agricultural research in developing countries has induced a process of review of priorities and of questioning past strategies with the aim of enhancing the efficiency of the process. Concurrently concern about the sustainability of production systems ranks very high in the minds of decision makers.

CIAT's publications (CIAT International and the journal *Pasturas Tropicales*) recently reported on the successful diffusion of the forage legume *Stylosanthes guianensis* CIAT 184 in Southern China. This is a particularly interesting case of international cooperation because a material originally selected as a forage legume to be included in mixed legume-grass pastures for the grazing systems of the Latin American tropical lowlands, found its way to intensive smallholder systems of tropical and sub-tropical China, where it is used for forage and leaf meal production. The latter is an important ingredient for pigs, poultry and fish compound feeds.

IDRC was involved in this process firstly by funding part of the tropical pastures network (RIEPT) coordinated by CIAT and secondly by supporting research on forages and specifically on *Stylosanthes guianensis* CIAT 184 with IVITA, a Peruvian research institution working at Pucallpa, Peru. The major constraint of *Stylosanthes* as a forage is anthracnose, a fungal disease destroying the stand. Contrasting behaviour of *Stylosanthes* close to the equator in Colombia and at higher latitudes (Pucallpa) led to the substantial research efforts into understanding the disease. This in due course led to the release of *S. guianensis* CIAT 184 as an anthracnose-tolerant highly productive cultivar for the lowlands of Peru by IVITA.

This material and information about it were broadly made available to participating national agricultural research systems (NARS) and also to the South China Academy of Tropical Crops (SCATC) at Hainan, China.

The objective of this report is to assess the extent of the diffusion and use of *S. guianensis* CIAT 184 and suggest any follow up action in Southern China. The terms of reference of the mission were:

- to study the extent of the use and adoption of the material in China
- to identify the factors involved in this process
- to examine the potential for enhancing the cooperation between the Chinese institutions and international partners, particularly CIAT and IDRC in this field, and
- to assess the value of undertaking a detailed impact study and ways of further promoting wider dissemination of the results.

## **2. Livestock production trends in China**

China with its population of about 1.2 billion people constitutes the largest and overwhelming economy in the Asian region. Land use is largely determined by its high population, the relatively low per capita incomes and the weak infrastructure fostering local self-sufficiency.

These factors have led to the development of farming systems oriented towards the efficient utilization of land to produce mainly cereals and vegetables with very limited use of external inputs. Animal production is based on farm-produced by-products fed mainly to non-ruminant and draught animals.

The evolution towards a more open market economy in China, as well as international trade and foreign capital investment have led to a very rapid growth process, (reaching rates of about 12-13% p.a. GDP growth in the recent past). This process is inducing drastic changes in all sectors of the economy. In the agricultural sector, one important effect of rising incomes is the substantial rise in demand for livestock products. Given foreign exchange constraints, self-sufficiency levels are still high and China even exports substantial amounts of pigmeat. Table 1 presents the growth rates of production for the major animal protein sources. These very impressive growth rates are achieved mainly through intensification. To some extent, this is linked to imports of feeds (grains, cassava chips etc.). One aspect of this is the supply of protein sources as a feed for improved animal production systems. In most countries this is achieved through the utilization of oilseed cakes and meals, such as soybean, groundnut, sunflower. In China many of these oilseeds are consumed directly by humans.

The production of forage meals is mainly from legumes that have been grown on land of limited cropping potential and/or in combination with fruit tree crops. The system makes maximum use of the ample labour supply in the rural areas, allows the efficient use of other farm by-products by feeding animals, and recycles nutrients by integrating animals into the system. Thus on-farm production in the rural areas is seen as having an important role as a source of economic growth in the near future (until rising opportunity cost of labor and lower transport costs favour more specialized systems).

TABLE 1

Livestock production in China: Annual growth rates and per capita production levels (1981-1991)

Main animal products	China	Developing countries in Asia	World	Per Capita production	
				1981	1991
	%	%	%	kg	kg
Total meat production	7.9	6.6	2.8	15.71	27.60
Pigmeat	7.6	7.2	3.2	12.38	22.02
Poultry	6.9	6.5	4.2	1.83	3.00
Beef/Veal	20.9	5.7	1.6	0.24	1.13
Hen Eggs	11.7	9.1	3.0	2.40	5.92
Milk	9.1	5.4	1.3	3.16	6.48

Source: FAO/RAPA (1992) Statistical Profile of Livestock Development in Asia Pacific Region (1981-91)

### 3. Status of Stylosanthes Use

#### (A) Hainan Island

Farming systems in both Guangdong and Hainan involved mainly intensive rice production in the lowlands together with groundnut, soybean and mungbean as cash crops. In the uplands, rubber, tea, fruit trees, cassava and sweet potatoes are grown. In southern Hainan we saw extensive areas of marginal lands in coastal areas, which are potentially important for cultivating with *S. guianensis*. We could see the agronomic adaptation of Stylo. some of this land is communal grazing land for ruminants, but we were told that as soon as somebody plants trees or for that matter Stylo, the person accrues property rights to the production. We were told that about 130,000 hectares of marginal lands exist in Hainan. Stylos could play an important role in reclaiming these marginal lands.

In Guangdong the traditional cultivar *S. guianensis* cv Graham is more widely grown and sought by farmers, whereas in Hainan *S. guianensis* cv CIAT 184 is said to be more widespread because of greater anthracnose tolerance, but real reasons for these differences are not well documented. In Guangdong, the main argument for CIAT 184 is higher yield. This advantage is traded off with the lower seed yield, virtually requiring the purchase of seed produced in Hainan. Given the poor infrastructure and the lack of an effective seed market this is a practical constraint on the diffusion for the time being. Seed distribution is basically handled by the agricultural administration which subsidizes the use of Stylos, particularly 184. Farmers are given seed free as well as some fertilizer. The communication between the state farms producing the seed in Hainan and the agricultural administration of Guangdong, the main or only client seems to have some problems. There does not seem to be a parallel market in CIAT 184. The Guangdong administration seems to buy it in Hainan for about 24 yuan/kg (about US\$ 3). Seed of Graham seems to be traded for 46 yuan / kg. Given the latter price, producing Stylo seems to be very attractive. We do not know what volumes are traded at these prices.

Until 1988, Hainan was part of Guangdong and the work on pastures and forages had a common focus. Since they became separate territories, divergence of effort is evident. There is good scope to plan a more integrated effort and complimentary strategy.

In animal production, non-ruminants (pigs and poultry) are the most important sectors, followed by cattle, buffaloes, goats and ducks. In the more marginal areas of Hainan, beef cattle and goats are raised extensively. Swamp buffaloes are used for draught and also haulage.

#### (1) Seed Production

*Stylosanthes* together with other forage materials were introduced in 1982 by CIAT. Initially, its suitability and adaptation was tested at three sites in three cities: Hainan and Guangdong Provinces. These agronomic trials proved successful and seed multiplication was further extended to state farms in Ledon and Sanya in south and south western Sanya respectively. We were told that seed production is based mainly on four state farms. We did not see private farmers using the material.

#### (i) Management

Stylo seed production is managed as an annual crop. Seedlings are produced in raised beds at a sowing rate of 37-50 kg/ha with high fertilization, including 2500 kg of organic fertilizer, 7500 kg of farmyard manure and 225 kg of superphosphate. At transplanting fertilizer is applied at a rate of

150-225 of superphosphate, and 4500-7500 kg of organic fertilizer/ha, lime as appropriate to reach a pH of 5.5). It takes four persons per day to plant one mu (1 ha = 15 mu).

### **(ii) Harvesting**

When the stand is more than 85% ripe, the plants are cut. 30% of the seeds are harvested from the cut plant. The remaining 70% of the seeds are found on the ground and are recovered by sweeping them plus the soil for processing. In the Le Dong seed farm, with about 667 ha, about 67 ha is under seed production. It takes one month to complete the harvesting (6-7 days/mu). Groups of 15 persons harvest 100 mu plots. There is only one harvest per year. Generally, the men undertake the physical harvesting work and the women deal with collecting the cut material and sweepings (seeds plus soils) into the bag and also processing. The bags are then transported to barns.

### **(iii) Seed Processing**

On average about 25 kg of seeds are produced per mu or 375 kg/ha. The transported material is sent to the farm where it is sieved and the seeds are separated from soil. These are then placed in 50 kg bags where the name of the farm and date of harvesting are indicated. From each bag, samples are taken for grading (A, B and C) based on purity, germination rate and presence of weed seeds. Where weed seeds are above certain thresholds, further manual cleaning is used. It takes about 5 person/days to process 25 kg of seeds, which is the yield from 1 mu. Women undertake most of the seed processing work.

The impression transmitted by the farm manager was that this was a highly profitable operation and that the farm would like to produce more seed if there was a market. Given Chinese price ratios seed production must be very attractive. A farm worker receives about 200 yuan per month, which is equivalent to the value of less than 9 kg of Stylo seed.

## **(2) Stylosanthes Meal Production**

Stylo hay is produced at five sites on Hainan island. The overall operation from cutting to collection, transportation, processing and meal production appeared rather inefficient.

At the farm we visited the forage is cut by a small tractor with a front-end rotating cutter. The material is heaped together using forked sticks and transported to the farm. The operations we saw in Xishi cattle farm indicated considerable maturity of the stand at the time of harvest, considerable wastage of leaves on the ground and incomplete collection. This particular stand was three years old. Four cuts were achieved here compared to two in Guangdong.

The hay is dried for about 2-3 days before it is ground. The grinding process was extremely slow (200 kg/hr), and the final product is a flour. It is not at all clear why the meal was being produced with such a small particle size, although it is well known that it is principally for feed pigs and poultry. The selling price of the meal is one yuan/kg but the price is very variable. The average crude protein content is about 12-13% of DM.

The meal is mainly used as is to feed pigs, poultry and ducks, but is increasingly also fed to cattle and fish. The meal is also used as an important ingredient in mixed feeds for pigs and poultry. The fresh forage is also chopped and fed directly to pigs and rabbits.

### (3) Guangdong Province

Interest in tropical pastures and legumes in Guangdong province started around 1981 with assistance from Australia. The focus was on forage production to overcome the main problem of inadequate animal nutrition. Guangdong has about 2.4 million hectares of farm land in which the average size of a farm is 1 ha.

Stylos are mainly grown in mountainous areas on marginal soils frequently in combination with the establishment of perennial crops, such as fruit trees, rubber, etc.

The production of Stylo feed was actively promoted by the provincial agricultural administration. A program was established in 1989 with an annual budget of two million yuan (US\$ 250 000) to promote the utilization of forages, particularly stylos. The program mainly subsidizes stylo seed and some fertilizer, and does extension work. This has just been extended for another five years and it involves eight institutions including universities and the academy of sciences.

Associated with this there has been a significant development in the use of *Stylosanthes*, notably *S. Guianensis* cv Graham. It is estimated that about 113 000 ha ( 5% of the land area of the province) is under *Stylosanthes* in which some 108,000 farm families are involved. Ecotype CIAT 184 is the more recent introduction. Our hosts were not able to estimate the share of CIAT 184 of those 113 000 ha of Stylos. The relative importance of the areas under these cultivars can be assessed from the annual planting estimates shown below:

TABLE 2  
Areas sown to Stylos in Guangdong province

	S. guianensis CV Graham	S. guianensis CIAT 184
1989	6,073 ha	3,900 ha
1990	14,500 "	8,700 "
1991	13,400 "	10,000 "
1992	16,000 "	8,000 "
1993	23,000 "	5,200 "

The above figures were developed by the Agricultural Administration of Guangdong province apparently based on seed distributed each year assuming certain seeding rates. The area of Cv Graham may be larger than implied by these figures because farmers produce their own seed of this material. The persistence of CIAT 184 was said to be up to 4 years in favourable locations and down to one year in the colder North of Guangdong. There seems to be a need for materials playing a similar role in the farming systems to the one of Stylo but better adapted to continental climates (hot summers, cold winters).

#### **4. Institutions**

There are several features about the institutions and personnel which are worth noting:

(1) In Guangdong the work on tropical pastures and forages is undertaken by South China Agricultural University (SCAU) and the Bureau of Animal Husbandry (BAH). Excellent cooperation exists between the two. In Hainan, SCATC is responsible for the work.

(2) Links exist between SCAU and SCATC but are loose. Good opportunities exist to promote stronger links between the two in the context of defining a more focused research and development program on *Stylosanthes* and forages in general.

(3) In both provinces, excellent links exist with state farms and the extension services. The delivery mechanisms for technology application are therefore very good and is one of the key features about the "success" of technology transfer in China. To a large extent the process is driven top down by the public sector. It will be interesting to observe how the diffusion of these materials is affected by less intervention and more market driven development in the coming years.

(4) In both places, there is a remarkable and noticeable willingness by the elderly Professors and Heads of Departments who cannot speak English to encourage the more enthusiastic, willing and English-educated younger generation. Many of these have had training in CIAT, Australia, New Zealand and elsewhere and are eager to further learn and move forward.

(5) Given the investments already made on these well-trained individuals, they should be used to further develop research and development strategies. They also represent valuable contact points for aid agencies.

(6) The overall research capacity is very weak, and is a good reason to provide further support and use the trained manpower.

(7) The research and development plans are unclear and lack both clarity and vision. Extensive germplasm introductions of grasses and legumes exist, but current and future plans are not very explicit. The limited research we were shown was exclusively on small plots, budgetary constraints do not allow research involving animals.

(8) In Guangdong, the laboratories are extraordinarily well equipped with various instruments. However, most of them were unused and very little activity was evident. Operating funds were evidently very scarce. In Hainan, the equipment was meager.

(9) In SCATC in Hainan, the legume and grass programme has been merged with cassava and sweet potatoes, and upland rice. Animals are expected to be included. The new grouping offers an important entry point for future work on upland systems.

(10) The staffing of the tropical forages group in SCATC is 12 (10 graduates and 2 middle school persons). The new Institute of Agriculture and Animal Husbandry (IAAH) will have a staff strength of 21 persons. It will have three leaders (Administration, Research and Extension).

(11) Mr Liu Guodao, the current leader of the tropical forages group will become the research leader in IAAH. The group then has research and extension capacity, but is it doubtful that this strength can meet all the needs of South China. Mr Liu was awarded a top prize by the Ministry of Agriculture for

his efforts on forages, especially for the conversion of the "iron fence" to the "green fence" (use of living fences).

(12) There was no 'systems perspective' in all the research and development activities. In SCAU, ecological interest exists and the Vice Chancellor with six graduate students is personally involved. This is however not linked to a holistic systems view. There is a need for facilitating assistance in this direction.

(13) SCATC has made some moves to contact and link with other provinces in the area of tropical forages. A good opportunity exists to formalize a national network on the subject, which can in turn spur development. This stems from their efforts to identify themselves as leaders in tropical forages and expand their mandate to other provinces with a tropical (Hainan, Guangdong, Fujian, Yunnan and Guanzhi) and sub-tropical climate (Hunan, Jiangxi, Hubei and Jiangsu). In this process they have served the needs of the Department of Agriculture, Institutes of Agriculture and/or Animal Husbandry and the Agricultural Universities.

(14) SCATC is clearly recognized as a focal point by the Ministry of Agriculture in Beijing who keep in close touch with the group. They advise on research and development plans, provide some funds for research as well as promote attendance at national and regional meetings.

(15) IN SCATC, research priorities are set by wide discussion and concurrence within the research group and approval is finally sought from the Ministry of Agriculture in Beijing. Funding for this research is provided by the Ministry of Agriculture.

(16) SCATC has also undertaken training in the past, supported by the Ministry of Agriculture. Two national training programs, one in 1990 for about 25 farming families in Baisha County, and the other in 1982 on seed production for 23 farmers have been held, each lasting for 4 weeks. In addition, and at the request of the Ministry of Agriculture, a national workshop on pasture research was held in 1992 which was attended by 115 persons from all the provinces.

(17) The data collection is very loose and haphazard presently with different researchers recording all the information in the SCATC experimental plots in paper and books. Mr Liu has then the task to collate and interpret the data. Surprisingly, no computer facilities exist to store and process the information.

## **5. Implications**

(1) If economic growth trends continue at the high annual rates as is generally expected, the growth in demand for animal products will be substantial.

(2) Among the animal species, pigs and poultry are going to have the greatest increases in absolute terms, followed by beef and milk.

(3) A large proportion of the urban demand will be met from intensive commercial systems based largely on imported feedstuffs.

(4) As long as real employment is limited and the infrastructure is weak, on-farm production of animals based on locally grown feeds will remain competitive and can contribute to growth.



(5) Legumes produced on land with a low opportunity cost remains an attractive proposition to not only meet part of the protein requirements especially of non-ruminants, but also promote more intensive animal production.

(6) Associated with (2) and (5), the potential to expand the production of the meal not only for use in China, but also elsewhere in S E Asia should be analyzed. Examples of areas that can potentially benefit from this include Laos, Vietnam, N E Thailand, Philippines and Eastern Indonesia.

(7) The advances that have been made in the use of *S guianensis* CIAT 184 and the expanding area under this legume are impressive, and this germplasm has had an impact in South China.

(8) While researchers and extensionists seem to have a thorough empirical knowledge of the agronomy of Stylo as a forage crop, knowledge on its use in legume grass pastures is very weak. On the one state ranch visited pastures had been established on wasteland (sandy coastal areas) by plane. Only a few native grasses could be seen, the Stylo had heavy competition from weeds. Present management was to weed the pastures annually, resowing in patches and annual fertilization. If these "wastelands" are to be reclaimed with pastures, some applied research and training will be necessary.

(9) As the policy framework in China shifts from central planning to farmer responsibility there will be an increasing need to subject these forage technologies as well as others to rigorous economic analysis.

(10) The weak research capacity, presence of promising well trained young scientists, the growing importance of animal production in China justify further support for tropical forages research and extension in a systems context.

(11) For IDRC, support through RIEPT for the work in China has clearly had an impact well beyond the fact that Chinese farmers have one more option to develop their farming systems. The case of Stylo 184 proves the value of international cooperation in agricultural research and particularly the networking approach. It furthermore proves that scientists are weak at forecasting the impact of their research and thus results have to be made available as broadly as possible to maximize the chances that useful applications are identified.

(12) The successful first step of this cooperation between Chinese institutions and CIAT/IDRC, opens up a vast potential to jointly develop sustainable agricultural systems for the largest country of the world. This is particularly relevant for the Chinese case because the very limited resource base per inhabitant can rapidly lead to resource degradation as farming systems have to adapt to the extremely high pace of economic growth and the associated changes.

## **6. Suggestions for follow-up**

The following suggestions are made:

(1) Convene a small workshop to involve the participation of not only the SCATC and SCAU researchers but also others who are directly concerned with tropical forages research. The main objectives are to encourage scientists to document and make available all available information on the subject based on the work done. With this input and the participation of outsiders the group can discuss new strategies, and seek consensus on future direction.

(2) The Workshop can also formalize a network on tropical forages, based on the linkages between SCATC and several other institutions. CIAT and IDRC can be catalytic in providing much needed further support for this network.

(3) The impact of S guianensis CIAT 184 germplasm is obvious. The current status and growing future importance merit capture. The usefulness and feasibility of a socio-economic and environmental impact study would be decided once the state of the arts is known. Should it not be feasible to undertake such a workshop as proposed under (1) the commissioning of detailed literature reviews in English could help to make a decision on an impact study. A video presentation that can also draw from the workshop results, reflect the varied uses at the farm level and project potential importance, will be especially useful to demonstrate the benefits to Canadian and other audiences.

October 20, 1993

## **PERSONS MET**

### **(A) Guangdong**

- 1) Prof Luo Shi Meng, Vice Chancellor  
South China Agriculture University (SCAU)
- 2) Prof Chen Dexin,  
Department of Animal Husbandry (SCAU)
- 3) Mr Lu Xiaoliang  
Department of Animal Husbandry (SCAU)
- 4) Dr Xiaolong Yan  
Department of Soil and Agrochemistry (SCAU)
- 5) Dr Z Dan Shi  
Department of Animal Husbandry (SCAU)
- 6) Mr Lin Jian Yi, Head of Station  
Guangdong Provincial Bureau of Animal Husbandry (BAU)
- 7) Mr Li Juzheng, Managing Director  
Agricultural Zoning Society

### **(B) Hainan**

- 1) Prof Jiang Houming. Agronomist  
Tropical Pasture Research Centre (TPRC)
- 2) Prof Xin Yinen, Agronomist, (TPRC)
- 3) Eng. He Huaxuan, Agronomist (TPRC)
- 4) Mr Li Jiang, Agronomist (TPRC)
- 5) Eng. Liu Guodao, Agronomist (TPRC)
- 6) Prof Wang Shuran, Office Chief (TPRC)
- 7) Mr Ong Shixiong, Xishi Cattle Farm
- 8) Mr Wang Jinji, Xishi Cattle Farm
- 9) Mr Fu Gui Xi, Xishi Cattle Farm
- 10) Mr Fu Nan Ping, Tangmayuan Cattle Farm
- 11) Mr Yan Yirang, Tangmayuan Cattle Farm

## TRAVEL ITINERARY

### (A) Guangdong

**4 Oct:** CS arrives in Guangzhou. Preliminary discussions.

**5 Oct:** CD arrives in Guangzhou, Discussions with Prof Chen Dexin and his colleagues in the South China Agricultural University (SCAU), and officials from the Guangdong Bureau of Animal Husbandry (BAH)

**6 Oct:** Visit laboratories and facilities ion SCAU

AM Final discussions with the research team in SCAU and BAH.

PM Leave Guangzhou for Haikou (Hainan).

### (B) Hainan

**7 Oct:** AM Visit Tropical Pasture Research Centre, visit field operations on tropical pastures and have discussions with research team.

PM Travel to Yacha City (Baishu County) and visit the Xishui Cattle Farm and have discussions with field staff.

Travel to Basuo City (Donfang County)

**8 Oct:** AM Visit Tangmayuan Cattle Farm and have discussions with field staff.

Travel to Le Dong Seed Farm and have discussions with field staff.

PM Travel to Baoluo City (Le Dong County), and then to Yacha City (Qiong Zhong County).

**9 Oct:** AM Visit Fenmu deer farm.

Return to Haikou City.

PM Final discussions with Mr Liu and Prof Xin. CS leaves for Latin America.

**10 Oct:** AM Final discussions with Mr Liu and Prof Xin

PM CD leaves for Singapore

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